

Financial Performance of Contract Tree Farming for Smallholders: The Case of Contract Eucalypt Tree Farming in Thailand

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Abstract Eucalypt (*Eucalyptus spp.*) tree farming is a source of income for many smallholders in developing and emerging countries and critical to the resource supply of many pulp and paper companies. These companies rely on smallholders adopting tree farming, sometimes by offering a contract. This paper reports a study from four regions of Thailand, where smallholder eucalypt tree farming is practiced, which investigated the financial performance of contract eucalypt tree farming for smallholders. A total of 82 contract eucalypt tree farmers and 81 independent tree farmers were systematically selected and surveyed in these regions, using door-to-door personal interviews. Focus groups and key informant interviews were also used to gain in-depth understanding of the issues. An investment appraisal analysis was used to determine and evaluate comparative financial returns from various cutting cycle periods, through computation of the net present value (NPV). There was no evidence that contracts increase the NPV of tree growing. It could be that tree growers entered into a contractual agreement with the expectation of higher benefits and the importance of this expectation diminishes as the crop matures, and tree farmers appreciate the strong market for eucalypt wood in Thailand. Contracts do not increase inequalities in terms of income but they might increase inequalities in terms of knowledge, because farmers with more land have better access to new knowledge provided by the contracting company.

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Introduction

Smallholders are increasingly being contracted by the forest industry for tree farming (Cossalter and Pye-Smith 2003; Evans and Turnbull 2004).¹ The most popular arrangement is known as the *outgrower scheme* or *contract tree farming*. It implies that smallholders are largely responsible for the wood production, with the company guaranteeing purchase of the product (Desmond and Race 2000). This type of contractual arrangement was first established for the production of agricultural crops. In agriculture, the benefits of contract farming for smallholders are widely debated. Main criticisms are power imbalances between companies and farmers, risks for farmers and threats to social justice (Wilson 1986; Clapp 1994; Little and Watts 1994; Key and Runsten 1999). For instance, specialisation in the contract crop and consequently high dependence on this crop decreases smallholders' bargaining power (Key and Runsten 1999; Singh 2002; Warning and Key 2002).

Contract farming has been supported by many state and private companies, and by third parties including development banks and lending agencies, which advocate contract farming to help build partnerships between smallholders and the private sector and increase the transfer of innovation and market growth (Little and Watts 1994). Many sources (e.g. Scherr et al. 2002; Mayers 2006) agree that contracts for tree farming contribute to increased adopters' cash income. In South Africa for instance, the average household's net revenue from contract tree farming is estimated to be US\$800/ha over 6 years (Cairns 2000). The literature presents the results from contract farming in terms of income (Mayers and Vermeulen 2002) but does not compare financial returns from contract farming versus independent farming. In the case of contracts for tree farming, the difference between revenue from contract tree farming and independent tree farming is unlikely to make a large difference in the total household income. It would be difficult to determine how much of the variation in income is due to the contract. It is, therefore, inappropriate to examine the contribution of contracts for tree farming towards the total household income. Because of the long-term nature of tree farming, it seems much more appropriate to compare the NPV of tree farming under contract to the NPV outside contract.

The increase in NPV of tree plantations is usually due to the use of higher quality planting stock (seedlings, tissue culture stock and rooted cuttings) and the provision of technical advice. Contracts give smallholders access to high yielding clones that can increase the productivity of their plantation. Technical advice can include recommendations on what clones are suitable on the smallholders' sites in order to maximise yield (Harrison and Herbohn 2001; Thaitusa 2002). Technical advice can

¹ The report on the state of fast-wood plantations by Cossalter and Pye-Smith's (2003) was subject to extensive expert review and is widely regarded as a definitive overview of the status of fast-growing tree plantations.

also encourage tree farmers to improve land preparation and follow better management practices. Thaitusa (2002) stressed the importance of ploughing in increasing tree yield.

The objective of the present research is to investigate the financial performance of contract eucalypt tree farming for smallholders. This research is part of a larger project which also investigated the drivers of adoption of tree farming and of contracts in Thailand; these results are presented in separate papers (Boulay et al. 2012; Boulay and Tacconi 2012) and a PhD thesis (Boulay 2010).

Case Study Context and Location

Three major pulp and paper companies in Thailand contract at least 60,000 tree growers² to operate in overlapping geographical areas, namely Advance Agro in Chachoengsao, Siam Forestry in Ratchaburi and in Kamphaeng phet, and Phoenix Pulp and Paper in Khon Kaen. The arrangement of contracting is specified in terms of what is to be produced, how it is to be produced and what commitments are made for future sale (timing, location and price). Individual contract tree growers sign a contract with a company. The company has to provide high quality and low-price planting materials and fertiliser, free technical advice and training on management practices. For example in 2008 Siam Forestry sold rooted cuttings at 2.5 baht³ each to members and 4 baht each to independent tree growers. The company also guarantees buying the entire production of wood at prevailing market prices or at fixed minimum prices at the end of the rotation. Based on their demonstration plantations, Phoenix Pulp and Paper (Salee 2009) estimated average yields from first and second rotations: 12 tonnes per rai after 3 years and 15–16 tonnes after 4 years for plantations from rooted cuttings or tissue culture stock, and 6 and 8 tonnes for plantations from seedlings, respectively.

Contract tree growers can establish eucalypts in block or linear planting (for example on paddy bunds).⁴ *Eucalyptus camaldulensis* was the most popular species planted. In the case of block planting, eucalypt tree growers can plant an intercrop (for example cassava) in the first year. In the second year, intercropping is difficult because of the shading of the trees and competition for water and nutrients. Contract growers are committed to sell their full crop to the company. In some villages located near pulp and paper mills and where there are no competitors, a company accepts that farmers sell to a middleman because all middlemen in this area sell to the company. Contracts from all companies include the condition that the contracted growers have to sell to the company no later than 7 years from the date of planting.

² At least 6,000 are contracted by Advance Agro, 50,000 by Phoenix Pulp and Paper and 4,000 by Siam Forestry. Siam Forestry would contract between 2,500 and 3,000 tree growers in Kanchanaburi (Barney 2005).

³ 1.00 USD = 30.12 Thai baht (04/15/2011).

⁴ Paddy bunds are raised pathways of approximately 1.5 m width between paddy fields. The relatively simple operation of bund-building enables people to control water and stabilise their cropping.

Between 2004 and 2008, the demand and the prices of pulp and other raw materials for paper production have been increasing⁵ and Thai pulp and paper companies started sourcing wood supply further away from the mill (ADB 2005a; Wiriyapong 2008). Advance Agro and the Siam Cement Group have positioned themselves to lease large concessions to establish eucalypt plantations in Savannakhet province, Lao PDR and Cambodia (ADB 2005b). In Savannakhet province, 20,000 ha of eucalypt concessions are leased by Advance Agro and 12,000 by Phoenix Pulp and Paper. The managing director of Siam Forestry stated that the company is trying to secure supplies of raw material for the future (Wiriyapong 2008).

Research Method

Two main methods were used to collect qualitative and quantitative data. To collect data on the companies' work, key informants were interviewed. To collect extensive quantitative data, a household survey was conducted.

Information needed to understand better the local context and the adoption of contract tree farming was collected through semi-structured personal interviews with key informants. Extension officers from the Siam Forestry and the Phoenix Pulp and Paper companies, and a large landholder who worked closely with Advance Agro, were asked to describe in detail the terms of the contract, their extension work, the strategies followed by the company for promoting contracts and the problems they encounter. They also provided data on the areas involved, what areas are most suitable for eucalypt tree farming, the number of contract tree growers, the prices of planting materials and wood, and the market conditions.

The assistance of all three companies was requested to indicate all the geographical zones and provide a list of the villages where they had contracted tree growers. The researcher then randomly selected villages from this list. A total of 82 contract eucalypt tree farmers and 81 independent tree farmers, all of whom had already harvested trees,⁶ were systematically selected and personally interviewed at their properties. To measure financial performance of tree planting under the program, respondents were asked to list all the costs and revenue involved in their tree farming activity. They were also asked about the rotation length and how many harvests had already been conducted with the current eucalypt plants, because eucalypts regenerate naturally by coppice, but yield is likely to decrease with the number of harvests from the same plants. Tree growers were also asked what type of planting materials they used (seedlings, tissue culture stock or rooted cuttings) and where they purchased these (e.g. from a middleman, private nursery, contracting company or another company). Although the yield depends on land quality and local climate, tree growers were asked about the yield they obtained (in green tonne

⁵ As an example, prices of imported scrap paper have from US\$140 per tonne in May 2007 to US\$250 May 2008 and domestic prices from 4 to 6 baht/kg (Wiriyapong 2008).

⁶ It was necessary that the tree growers sampled had adopted eucalypt tree farming for at least one rotation so that impacts were identifiable.

per rai).⁷ They were also asked the price of wood received (baht/green tonne) when sold as stumpage, delivered to a company's delivery centre or delivered to the mill gate. The questionnaire was tested on tree growers not included in the sample.

The fieldwork was organised so that one *moo* (the administrative sub-division of a village in Thailand) could be surveyed per day. The head of the village was first visited and told about the research. The team of interviewers would split at the temple, walk in different directions and survey each *n*th household in every street. The number *n* was determined by dividing the number of households provided by the head of the village by the number of respondents to be interviewed.

Estimate of Financial Performance of Tree Planting Under the Outgrower Scheme

Because not all tree growers adopt the same rotation lengths, the most acceptable method to compare the costs and revenues from eucalypt tree farming between contract and independent tree growers is discounted cash-flow analysis, which accounts for the time value of money. The NPV was used as a measure of financial performance including to compare alternative cutting cycle periods. Costs included in the calculation of the NPV were land preparation, planting materials, fertiliser and of herbicide, weeding, logging and transporting logs. While respondents provided costs for hired labour, not costs were included for their own labour, on the grounds that this was unlikely to vary between contract and independent tree growing. The calculation of the NPV also included revenue from last harvest of eucalypts and revenue from intercropping. Results for paddy bund and boundary plantings are presented separately because most block-planting tree growers could give information on costs and revenue in baht per rai whereas paddy bund and boundary tree growers could only give this information in baht per tree.

A constant price analysis was adopted for the NPV calculations, assuming that all input cost and product price levels increase at the same rate over time. In developing and emerging countries, interest rates—which are between 8 and 15% since the Asian economic crisis of the 1990s—are generally higher than in developed countries. A review of interest and discount rates used by previous studies of forestry, agroforestry and agriculture, and those set by the Central Bank of Thailand, helped determine the most appropriate discount rate for the case study. Those most relevant were:

- In 2006, the interest rate fixed by the Central Bank of Thailand was 6.5% (ESCAP 2007).
- A study by Wannawong et al. (1991) of financial decisions in agroforestry systems in north-eastern Thailand used a real discount rate of 8% based on 1985 economic data from Thailand.
- A study by Tiwari (2000) of the lowland irrigated agriculture system in the northern plains of Thailand used two real discount rates, of 12 and 6%, as a response to both suggestion and criticism of the lower discount rate.

⁷ 1 ha = 6.25 rai.

- A 10% real discount rate was used for a cost-benefit analysis for the interactions between various land uses in Thailand (Albers and Robinson 2007).
- A real discount rate of 10% was also used to examine financial performance and economic analyses of reforestation in Thailand (Niskanen 1998a, b).
- A real discount rate of 10% was used for assessing the financial performance of eucalypts in agroforestry systems in India, for rotations ranging from eight to 10 years (Maille 1991).

On the basis of these previous studies, a real discount rate of 10% was chosen as the baseline for this research. The sensitivity of results to the discount rate was assessed by conducting sensitivity analysis with rates of 6 and 14%.

Results and Discussions

Contract Conditions and Prices Offered by the Companies

As presented in Table 1, two of the three companies provided contracts that guaranteed a fixed minimum price for mature trees to be paid at the time of harvest and agreed to pay a prevailing market price if, at that time, this market price was higher than the fixed minimum price. For contracts signed with Siam Forestry and Advance Agro in 2008, the fixed minimum guaranteed price was 800 baht/tonne for small-end log diameters under bark over 2 inches. Between 2011 and 2013, when contract tree growers harvest, they are guaranteed to receive this minimum price if the market price is lower.

When the market price is higher than the fixed minimum guaranteed price, the three companies pay the same price (market price) to everyone (middlemen, independent and contract tree growers) without checking the origin of the wood (supplier and plot).

In all cases, prices vary with tree diameter (Table 2). The three schemes require that contract tree growers deliver the wood to the mill gate or to the company's delivery centres. Contract tree growers may choose to hire contractors to harvest and transport the wood, or to do these tasks themselves, and may need to hire a truck or they may have their own for log transport.

None of the contractual arrangements from the three companies include any provision of credit, and in most cases not even credit in kind (e.g. inputs) are deducted from the purchase price. None of the schemes covers insurance or financial assistance in case of trees damaged by pest or fire. The growers bear the risks associated with wood production. The company has the right to limit its purchase to the trees that are not damaged.

None of the contracting companies in Thailand require tree growers to have a minimum area under eucalypt trees. Salee (2009) explained that companies contract as many smallholders as possible within an economically viable radius irrespectively of the size of landholding. However, the three companies require clients to hold a land tenure certificate and this provides legality for the resource. Tree growers who do not have a land tenure certificate can ask the head of the village to write a land tenure document in which the village recognises their rights to the land.

Table 1 Terms and conditions of contracts offered by the three contracting companies

Duties and prohibitions for both parties	Phoenix Pulp and Paper and Siam Forestry	Advance agro
Duties of the company	<p>Give technical advice about land preparation, planting, spacing, and stand maintenance (not written)</p> <p>Purchase wood (not written)</p> <p>Phoenix: <i>pay market price</i> at mill gate</p> <p>Siam Forestry: <i>guarantee fixed minimum price</i> at mill gate</p>	<p>Give technical advice about land preparation, planting, spacing, and stand maintenance</p> <p>Replace planting stock in case of disease problem</p> <p>Purchase wood</p> <p><i>Guarantee fixed minimum price</i> at mill gate</p>
Duties of the contract grower	<p>Buy planting stock from company (at a lower price than for independent growers)</p> <p>Follow technical advice (if technical advice is not followed, the fact that growers incur a sanction is not written)</p> <p>Harvest after <i>minimum 4 years</i> and no later than 7 years</p> <p>Sell wood of diameters greater than 2.5 inches to company (grower can dispose of smaller-diameter wood)</p>	<p>Buy planting stock from company (at a lower price than for independent growers)</p> <p>Follow technical advice: company can renege on purchase or pay lower price if wood quality is insufficient because grower did not follow technical advice</p> <p>Inform company of harvesting intention (assists the company in regulating the flow of input)</p> <p>Harvest <i>at 5 years</i> and sell to company</p>
Prohibitions for growers and fines	<p>Selling planting stock bought from company ('incurring a fine' is not written)</p> <p>Planting with a different tree spacing than recommended or harvesting before 4 years</p> <p>Selling wood to other buyers ('incurring a fine' is not written)</p>	<p>Selling planting stock bought from company, fine 50 baht/plant</p> <p>Producing planting stock by vegetative propagation</p> <p>Selling wood to other buyers, fine: 50 baht/ton</p>

'Not written' refers to items that are implied by the contractual arrangement but not included in the contract document

Table 2 Mill gate prices paid to contract and independent tree growers (baht per green tonne of wood, with bark)

Year and company	Small-end log diameter under bark (log 2.5 m long)			
	1 inch ^a	> 1.5 inches	> 2 inches	> 2.5 inches
2008				
Siam Forestry	550	700	1,200	1,250
Advance agro—Phoenix Pulp and Paper	550	700	1,200	1,200
2007				
Siam Forestry—advance agro	800	1,000	1,300	1,350
Phoenix Pulp and Paper	750	750	1,200	1,200

^a 1 inch = 2.54 cm

The three companies offer identical conditions to each smallholder with whom they establish a contract, in order to avoid negotiating with individuals. It is as if companies are looking at a supply curve (of how many smallholders will adopt a contract with them, according to the attractiveness of the offer), and choosing where to be on the supply curve. However, companies engage in *price discrimination*, including particular features in the contract which are more attractive to specific groups of smallholders. For instance, the companies pay more at the mill gate if tree growers are located far from the mill, to make the contract more attractive to those who are further away, and who might otherwise prefer to sell to a middleman. In this context, the extra amount paid by Phoenix Pulp and Paper to distant suppliers is 1.3 baht/tonne/km. The additional costs incurred by tree growers located further from the mill are exactly compensated by the increase in price they receive at the mill gate (so that attractiveness of the contract does not vary with the distance to the mill). Otherwise, tree growers have the option to deliver the wood to one of the company's delivery centres⁸ where they are paid the same price as at the mill gate. In 2008, one of the companies introduced a service for contract tree growers of harvesting the trees. Contract tree growers can contact the company to ask them to come and harvest their eucalypts within a week. The company pays them a stumpage price that is not a function of distance to the mill (whereas middlemen pay a stumpage price that takes into account the transportation cost of two baht/tonne/km). Siam Forestry in Ratchaburi offers a contractual 'package', in which the company is in charge of wood production (including planting and management during the first year), charges 10 baht/tree for this service, and pays a fixed guaranteed price of 1.2 baht/tonne after 4 years. It is the only contract in which the company guarantees a fixed price (as opposed to setting a fixed minimum price and paying more if market price is higher than this minimum). This form of agreement is limited to a few large landholders.

Smallholders frequently discontinue contracts and sell wood to buyers others than the contracting company. Contract tree growers with Phoenix Pulp and Paper who discontinue the contract should incur a fine of eight baht per tree, but action against defaulters is never enforced. Contract tree growers with Siam Forestry and Advance Agro who discontinue the contract are blacklisted by the company and will not be contracted again.

Companies also sell planting materials to tree growers who have no commitment to sell their wood to the company, but these materials are priced higher than those sold to contract tree growers. Table 3 presents the prices of the various types of planting materials across companies. Sometimes, companies withhold plants from the general (open) market as a way of enticing smallholders to adopt contract farming. At other times, companies sell the same quality planting materials on the open market, but at a higher price to independent growers. This strategy is facilitated by a lack of alternative sources of high quality planting stock.⁹

⁸ The three companies have between 5 and 100 delivery centres spread around their mill.

⁹ Planting stock can be purchased from sources other than the three companies, but the quality is typically lower. The areas that have access to company plants only are usually limited and close to a mill. For example, there is no private nursery near the Phoenix Pulp and Paper mill in Khon Kaen province, Chayapum province or Nongbua Province. However, there are many private nurseries in the area further north of the company's mill (in Udon Tani province).

Table 3 Prices of the various types of eucalypt planting stock for 2006 and 2008 (baht/unit)

Year	Seedlings		Tissue culture stock		Rooted cuttings	
	Siam Forestry	Phoenix Pulp.	Siam Forestry	Phoenix Pulp.	Siam Forestry	Phoenix Pulp.
2008						
For contract tree growers	1	1.25	7	n.a.	2.5	2.75
For independent tree growers	1.50	1.75	7	7	4	3.5
2006						
For contract tree growers	n.a.	0.5	1 ^a	n.a.	1	2.5
For independent tree growers	n.a.	0.75	2 ^a	n.a.	2	3
1997–2000	1	n.a.	n.a.	n.a.	n.a.	n.a.
1996	0.5	n.a.	n.a.	n.a.	n.a.	n.a.
1993–1995	Free	n.a.	n.a.	n.a.	n.a.	n.a.

Source Personal Interviews with company staff in 2008

n.a. is used when the company does not sell this item

^a In 2006, tissue culture plants were sold at a lower price (about two baht) because Siam Forestry was trying to develop them as an experiment rather than for profit

Financial Performance of Eucalypt Tree Farming in Block Planting

Data referring to a first harvest of block planting were analysed separately from data referring to subsequent harvests because the yield was likely to decrease between the first and second harvests from the same stumps. The NPV from eucalypt tree farming in block planting was compared between the two groups of independent and contract tree growers. The sample of block planting tree growers, for which the data are complete, included 56 independent tree growers and 55 contract tree growers. The NPV (defined as below) was estimated on the basis of best estimates of parameter values (in block plantings):

$$\text{NPV} = [(+\text{intercrop revenue}_1 - \cos ts_1)/(1+r)] + [-\cos ts_2(1+r)^2] \\ + [(\text{wood revenue}_t - \cos ts_t)(1+r)^t]$$

where NPV is the net present value of one tree rotation (in baht/rai); intercrop revenue₁ is the revenue from intercrop sold; costs₁ = capital outlays and operating costs for land preparation, plant purchase and planting; costs₂ = capital outlays and operating costs for fertilizer, herbicide, weeding and pruning (only done in year 2);

¹⁰ The use of intercrops (cultivated within an agroforestry system during first year only) is widely promoted by the companies because intercrops provide an opportunity to plantation owners to earn money both from primary crops and intercrops. However, intercropping is not widely practiced either because tree growers have no time to cultivate sugarcane or cassava as intercrop or because they do not know how to cultivate eucalypts with intercrops (Thaiutsa 2002; Salee 2009). Only 4 out of 39 tree growers had an intercrop during the first rotation, and 11 out of 75 for subsequent rotation.

Table 4 NPV of eucalypt tree farming in block for contract and independent tree growers at a 10% discount rate (baht/rai)

Rotation	Contract tree growers	Independent tree growers
First rotation ^a		
Mean NPV	3,467.4	4,115.1
Standard deviation	2,104.6	3,024.1
Median NPV	3,130.3	3,062.9
Minimum NPV	435.5	314.0
Maximum NPV	7,985.4	10,578.0
Subsequent rotations ^b		
Mean NPV	3,874.2 ^c	3,262.7
Standard deviation	3,671.7	3,364.2
Median NPV	2,597.1	2,213.6
Minimum NPV	307.3	159.8
Maximum NPV	16,582.3	14,321.7

Mean stand density was 270 plants per rai

^a $n = 22$ contract tree growers and 17 independent tree growers

^b $n = 34$ contract tree growers and 38 independent tree growers

^c The mean NPV is higher for subsequent rotations than the first rotation because of lower costs

costs_t = capital outlays and operating costs for harvesting and transport; r = discount rate; t = length of the first rotation (years) (which has a mean of 3.4 years).

Descriptive statistics of NPV estimates are summarized in Table 4. The NPVs were estimated under three discount rates (6, 10 and 14%). The discount rate had a relatively small impact on estimated NPV of eucalypt tree farming for contract and independent tree growers, due to the short rotation. As the conclusions are not sensitive to the choice of discount rate, the 10% discount rate was used for all subsequent analyses. The distribution of the NPVs was tested for normality using a Chi-squared test. The null hypothesis of a normal distribution was rejected. The difference between mean NPV of contract and independent tree growers was tested using a Wilcoxon rank-sum test and was not statistically significant at the 10% level.

Large variations were observed in NPVs within each group. The lowest NPVs corresponded to cases where tree growers had harvested 2 year-old trees. The discrepancy between mean and median NPV is explained by the large variation in maximum NPVs generated by the presence of a few highly profitable plantations.¹¹

Means and standard deviation were calculated for each of the major and minor components of the costs and revenue included in the NPV calculation, for contract and independent tree growers separately (for block planting and first rotation only). Means and standard deviation are presented in Table 5.

¹¹ Such variations in NPVs from tree farming have previously been observed, in South Africa for example (Mayers et al. 2001), and are caused by differences between tree growers in rotation length and management practices.

Sensitivity Analysis on the Differences in NPVs Between Contract and Independent Tree Eucalypt Growers Under Block Planting

Sensitivity analysis was used to explore the driving factors behind differences in NPVs between the groups, and hence identify those cost and benefit components that triggered large changes in profitability between groups. The NPV was calculated for contract tree growers as a starting point and each costs and revenue item was adjusted individually while keeping all others fixed. The change consisted of replacing the mean of this factor for contract tree growth with the mean from the dataset on independent tree growers. The new mean NPV and its percentage change compared to the benchmark NPV were recorded for each item. The percentages changes are summarized in Fig. 1.

The principal sources of variations in estimated NPVs are revenue from wood and revenue from intercropping. Interestingly, the effects in varying the two factors are opposite in direction and of a similar magnitude. The cancelling effect of these two factors may explain why NPV did not differ significantly different between contract and independent tree growers, although this warrants further assessment.

Checking back to the data, it was realised that among the sample of independent farmers there were four cases of intercropping (with cassava and corn), while there was no intercropping among the sample of those contracted. This could have created a sampling bias, because is no reason to presume that independent growers would intercrop more than contract tree growers. However, when revenue from intercropping was excluded, the median test for difference in NPV was still not significant.

Variations in the revenue from wood were investigated to address the question: 'Do contract tree growers achieve higher revenue from the sale of their wood?' No significant difference was detected in a *t* test on the difference between mean NPV of contracted and independent tree growers, excluding benefits from intercropping. Unfortunately, it was not possible to explore further the individual components of revenue, volume output and unit prices paid; full data were available for 14 tree growers only, all others selling their wood as stumpage and being unable to provide information on yield and price per tonne.

The analysis of the data collected from growers who had already harvested trees revealed that the price of wood received was lower than the 1,200 baht per tonne anticipated by the company. The main reason is that about two-thirds of the surveyed tree growers (107 out of 160) sold their wood as stumpage for 600 baht per tonne. Selling at a company's delivery centre is a more profitable marketing option: harvest and transport to a company's delivery centre cost an average of 206 baht per tonne¹² and increased the average price received for wood by 500 baht per tonne. The result—that smallholders do not deliver to the depot even though they could

¹² Average costs of harvest and transport to the mill gate were also lower for surveyed tree growers than anticipated by the company.

Table 5 Mean characteristics for the costs and revenues used in the calculation of NPV for the sample, block planting first rotation only

Sources of costs and revenues	Price/unit	Contract tree growers (<i>n</i> = 24)		Independent tree growers (<i>n</i> = 18)	
		Mean	SD	Mean	SD
1. Revenue					
Revenue from intercrop (year 1 only) (only 4 independent growers intercropped)	baht/rai	0	0	1,066.7	3,429.3
Estimated wood yield ^a	t/rai	9.8	6.3	7.4	5.2
Revenue from wood	baht/rai	6,819.1	3,775.4	5,405.2	3,657.0
2. Investment cost					
2.1 Planting and maintenance					
Labour costs					
Land preparation (year 1 only)	baht/rai	201.9	91.6	217.2	152.2
Planting (year 1 only)	baht/rai	26.6	70.7	83.6	164.2
Weeding labour (year 2 only)	baht/rai	9.7	34.3	25.7	82.6
Pruning (year 2 only)	baht/rai	9.2	31.2	0	0
Non-labour costs					
Plants ^b (year 1 only) (<i>n</i> = 161)	baht/rai	492.7	382.7	517.6	441.5
Fertiliser (year 2 only)	baht/rai	293.0	770.9	202.2	243.6
Herbicide (year 2 only)	baht/rai	53.7	142.5	82.8	127.1
2.2 Harvesting and transport^c					
Eucalypts (final year only) when delivered to the mill gate or to a company's delivery centre	baht/t	600			

The average stand density was 270 plants per rai

^a Yield was estimated using the revenue and average prices: 1,100 baht per tonne eucalypt wood price when delivered to the mill gate or to a company's delivery centre and 600 baht per tonne eucalypt wood price when sold as stumpage. Wood prices paid per tonne were collected from the most knowledgeable tree growers especially because most tree growers who sold as stumpage did not know their yield and wood price paid per tonne

^b Plant costs include costs of seedlings, tissue culture stock and rooted cuttings. The mean cost in block planting first rotation only is much higher because subsequent rotations are natural regeneration of the plants from the first rotation

^c Harvesting and transport costs is only for the wood not sold as stumpage

earn more by doing so—demonstrates that profit is not the only factor which determines their choices.

Tree growers who had already harvested trees were not asked about their satisfaction with the profit made but rather with the price of wood received. Among the independent growers, 76.5% were satisfied with the price of wood received whereas only 62.3% of contract growers were satisfied. These proportions were significantly different ($p = 0.047$ using a Chi-square test of independence). It is concluded that contracts were not beneficial in terms of price paid.

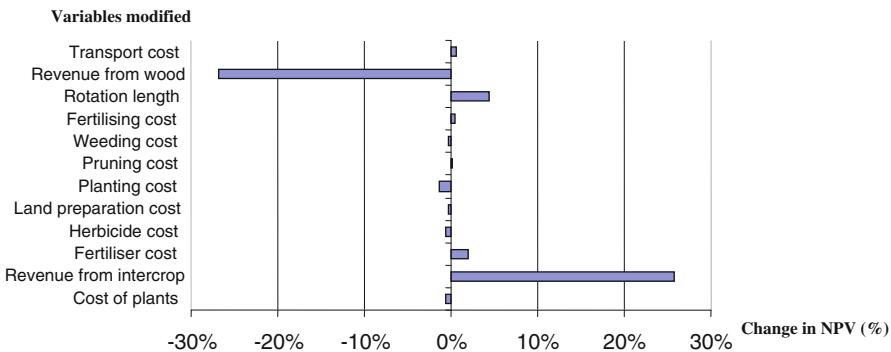


Fig. 1 Sensitivity analysis of the NPV for block planting (first rotation only): percentage of change in NPV of contract tree growers

Financial Performance of Eucalypt Tree Farming in Paddy Bund and Boundary Plantings

The same investment appraisal analysis was carried out for paddy bund and boundary plantings. The NPV from eucalypt tree farming was compared between the groups of independent and contract tree growers. The sample of paddy bund and boundary plantings tree growers, for which the data were complete, included 14 independent tree growers and 17 contract tree growers. Descriptive statistics of NPV estimates are summarized in Table 6. Based on a median test of first-rotation NPV, there was no statistically significant difference in NPV at the 10% level.

Data Limitations

A limitation of the data arises because the costs involved in the calculation of NPV were sometimes provided in baht per rai even though the revenue arose from selective harvest rather than from clear felling (for example, tree growers sold two tonnes per rai and planned to sell the rest of the wood later). It was therefore not possible to know what part of the costs should be taken into account when considering selective harvests. This limitation of the data would lead to underestimation of the NPV, and could partially explain why the NPVs achieved by sampled tree growers were much lower than that estimated by the company.

Conclusions

Based on results from the data collected after harvest, there was no evidence that contracts increased the NPV of tree growing. It could be that tree growers enter into a contractual agreement with the expectation of higher benefits and the importance of this expectation diminishes as the crop matures, and tree farmers appreciate the strong market for eucalypt wood in Thailand. This result is also relevant to whether the schemes in Thailand increase inequalities between farmers. Contract tree

Table 6 NPV (baht/tree) of eucalypt tree farming in paddy bund and boundary plantations for contract and independent tree growers (first rotation only) at a 10% discount rate

Rotation and NPV indicator	Contract tree growers	Independent tree growers
First rotation ^a		
Mean NPV	58.7	58.9
Standard deviation	62.9	74.4
Median NPV	28.4	38.5
Minimum NPV	3.4	1.8
Maximum NPV	177.6	257.0
Subsequent rotations ^b		
Mean NPV	21.9	14.5
Standard deviation	17.3	10.2
Median NPV	18.3	14.7
Minimum NPV	6.7	2.0
Maximum NPV	52.6	26.7

The distribution of the NPVs was tested using a Chi-squared test for normality. The null hypothesis of a normal distribution was rejected. The difference between the two groups was tested using a Wilcoxon rank-sum (Mann–Whitney *U*) test and was not statistically significant at a 10% level

^a $n = 11$ contract tree growers and 10 independent tree growers

^b $n = 6$ contract tree growers and 4 independent tree growers

farming has been criticised by Desmond and Race (2000) for increasing inequality between smallholders, because companies contract preferentially larger landholders to limit transaction costs. In the Thai case, the factor that is likely to increase financial inequalities between smallholders is the access to eucalypt tree growing rather than the access to contracts. There are major barriers to the access to eucalypt tree growing such as the availability of land, the lack of familiarity with tree growing and the spread of negative opinions about it through the social system (Boulay et al. 2012). There are no major barriers to the access to contracts. The companies welcome everyone (large and small landholders) to enter into their outgrower schemes because the demand for eucalypts is very strong. The challenge for the companies is to retain eucalypt growers. In Thailand, contracts do not increase inequalities in terms of income but they might increase inequalities in terms of knowledge, because farmers with more land have better access to new knowledge provided by the contracting company.

One of the most interesting results from this work and of Boulay et al. (2011) is that economic theory is not effective in identifying factors involved in adoption of contracts. Contract adoption factors are usually based on perceptions of impacts that differ from the measured impacts of contracts. There are two possible explanations to this: either contracts are adopted because they make farmers feel secure, or because farmers really think contracts will be beneficial to them (which does not prove to be true in terms of measured impacts). The absence of a significant difference in NPV achieved by contract and by independent farmers has to be considered in the specific context of the study and, in particular, Thai wood markets in 2007 and 2008. The local context of eucalypt wood production in Thailand was

providing attractive timber prices to all tree growers. However, it is possible that the same contractual arrangements could have been beneficial to farmers if the local context had been different (for instance, if farmers had not been able to market their wood independently). In conclusion, the benefits of contracts for eucalypt tree growing in Thailand refer to security in the case of a less buoyant market and not to quantifiable financial benefits under all circumstances. Provision of technical advice is the only clear benefit associated with the adoption of contracts in the case study.

This research suggests that the provision of information and technical advice, and some assistance for smallholders to organise themselves into associations, would facilitate contract tree farming. The most effective strategy for government would be the provision of independent technical advice. Smallholders are not well informed about desirable silviculture and the value of wood. This research suggests that extension programs may be the most effective way to promote contract tree farming for cases such as that of eucalypts in Thailand, where the poor reputation of eucalypts limits their adoption. The example of, and learnings from, contract tree farming in Thailand are of direct interest for similar cases, notably Lao PDR, where forest-based companies including Oji, Stora Enso and Phoenix Pulp and Paper are now seeking to expand their wood supply from smallholders.

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